MST e-NEWS

October 2011

INSIDE

2 From David's Desk

3 Are nanoporous materials radiation resistant?

4 Burgardt named 2011 American Welding Society Fellow

MST-8 researchers contribute to *JOM* special issue

5 Heads UP!

Ellen Cerreta

Discovering the secrets of failure in metals

By Diana Del Mauro
ADEPS Communications

Where workers usually tack memos and photographs on the bulletin boards above their desks, Ellen Cerreta has a row of sandwich bags filled with weapons materials.

In her office in the Materials Science Laboratory, one plastic bag contains bits of copper, which started as a hemishell about the size of half a chicken egg. But after being loaded with explosives, floated, and detonated, it looks like a "bag of cornflakes," she said.

As Cerreta examines the mechanical behavior of weapons materials, she tries to understand if there are characteristics of materials that make failure predictable. "I'm starting to feel the answer is yes, so how do you start to quantify that?" said Cerreta, who oftentimes finds herself turning to zirconium and titanium because "they are nice model systems for a lot of problems."

As the new Dynamic Properties team leader in Materials Science in Radiation and Dynamics Extremes (MST-8), a post she assumed in May after 10 years in the group, Cerreta oversees a dozen scientists, writes proposals for experiments she will lead, and publishes the results of her research.

She considers her first LDRD (Laboratory Directed Research and Development) project with co-principal investigator Darcie Dennis-Koller (Shock and Detonation Physics Group, WX-9) a turning point in her career. Together, they designed a gas gun and secured funding for its construction. Los Alamos scientists will use this vertical gun to study early-stage dynamic damage evolution.

"That's a big deal," said Laboratory Fellow Rusty Gray (MST-8), Cerreta's long-time mentor, who described the successful venture as "a mix of creativity, energy, push, and luck."

When Cerreta was wrapping up her PhD in materials science and engineering at Carnegie Mellon University in Pittsburgh,

continued on page 3

From David's Desk

Fall in New Mexico is one of my favorite seasons with the transition from the hot summer and rainy monsoons to fall colors, cool weather, and hopefully a good snowpack and ski season. Fall is also a time of transition at the Laboratory as we close out one fiscal year and restart a new one. As has been the standard for at least the last 10 years, we start the fiscal year with uncertainty with Congress authorizing spending under a continuing resolution. This uncertainty appears greater this year since Congress appears more serious about creating a balanced budget. I'm hearing optimism that we will not see serious cuts in our major programs, but possibly some program adjustments. Therefore, I ask that we be conservative and prudent in our spending for the next couple of months until we better understand our budget position. We're also in a period of Division leadership transition and I am honored to serve as acting Division Leader as Susan Seestrom selects a permanent candidate. In this role I will be working with the major program offices to minimize the impact of the fiscal year transition on the Division and our major capabilities.

This can be a stressful time of year given this uncertainty. Help keep an eye on our co-workers to make sure the stress is not affecting them negatively and having an impact on their health or safety. Several Laboratory resources are available to assist us in maintaining a good work/life balance. The Wellness Center offers a number of Health & Wellness courses throughout the year in addition to exercise classes. The Employee Assistance Program is also available. They not only provide in-depth counseling and support services but they have quick links to tools on stress management, relaxation, building better interpersonal skills, etc.

"…frequently opportunities exist in periods of uncertainty and our challenge is to recognize those opportunities and capitalize on them."

During any period of uncertainty, it's important to maintain an open line of communication and transparency. To help in the communications from the Division Office, I offer that I have an open door policy if you would like to come by and speak with me for a few minutes. For those that haven't kept up with all of the Division Office moves, we are currently residing in the MST-OB (TA-3, Bldg. 1415) rooms 220-224, second floor southeast corner. Also, I will be continuing the office hours at the various groups to give you a more convenient location to stop and chat with me. I would encourage you to use these office hours to bring me up to date on some recent research progress, possible program development opportunities, or simply general issues that you would like me to be aware of and help resolve.

I'd like to borrow a quote from Paul Dunn: "Out of chaos comes opportunity." I resonate with this philosophy in that frequently opportunities exist in periods of uncertaintly and our challenge is to recognize those opportunities and capitalize on them. I solicit your help identifying these areas of opportunities and I will champion realizing those opportunities into new capabilities or programs.

Acting MST Division Leader David Teter

Cerreta… she was unsure whether she belonged in academia, like her father, or industry. An unexpected answer came six months before she defended her thesis, when Gray approached her at a Gordon Research Conference.

"I wouldn't have considered working at a national laboratory if I hadn't met Rusty," she said, adding that she didn't then have a mental picture of what a national laboratory does.

Gray made a convincing argument that traditional structural materials, such as steel, titanium, and aluminum, offered better career options than the "latest sexy" materials that capture the covers of scientific journals. With airplanes, tanks, nuclear weapons, and body armor, there's a real-world need for scientists trained in structure-property relations.

In 2001, Cerreta joined MST-8 as a postdoctoral fellow.

Today, Gray describes Cerreta as a "very balanced" scientist, who serves on Laboratory scientific committees, inspires postdoctoral researchers and younger staff members, and pursues worthwhile science. Both Gray and Cerreta are active in TMS, the Minerals, Metals, and Materials Society, with Cerreta heading its Membership and Student Development Committee. Gray, a past TMS president, said Cerreta has the makings of society president.

Though Cerreta rarely sits in front of a microscope anymore, she said she strives to make "some small contribution" to advance the understanding and prediction of damage to materials – through projects she develops and complicated benchwork experiments she carries out with students and postdoctoral researchers.

"What I like about the problem is there are so many scenarios that are impacted by damage," Cerreta said. "You could imagine this being widely applicable . . . to auto industry crash work, foreign object damage in the aerospace industry, and earthquake-resistant materials for civil engineering. And that's very exciting to me."

Ellen Cerreta: My favorite experiment

What: Role of grain boundary type on dynamic damage evolution

When: 2010

Where: Materials Science Laboratory at Los Alamos National Laboratory

How: For some time, it has been understood that failure of metals initiates at boundaries, but which boundaries are likely to fail and why was unclear. We had hypothesized that the type or structure of a grain boundary should influence damage evolution under shock loading conditions. To this end, we examined both multicrystalline and polycrystalline specimens to determine mechanisms for such an effect and lend statistical support to the finding, respectively.

The a-ha moment: We found that certain types of boundaries were more resistant to failure than other types and were able to postulate a mechanism for this based upon the way in which line defects generated during dynamic loading, interact with different grain boundary structures. This finding was exciting, because while failure of metals is a stochastic process, it suggests that there maybe some deterministic features to failure.

We have conducted this research and published the polycrystalline results in the *Journal of Applied Physics*. Additional manuscripts related to the impact of this experimental work on molecular dynamic and mesoscale simulations are in preparation.

Are nanoporous materials radiation resistant?

When it comes to the operational lifetime of a nuclear power plant, the effects of radiation damage–swelling, hardening, embrittlement, and creep–are serious problems in critical components. Therefore, materials designed to be insensitive to radiation damage could result in more efficient nuclear energy sources.

MST and MPA researchers, in collaboration with other scientists from the United States and Argentina, have studied the effects of foam ligament size on the irradiation response. Their conclusion: foams can be tailored to become radiation tolerant.

In June, their research was published electronically in the American Chemical Society's *Nano Letters*. It also will be featured on the cover of the July 2012 issue of *Nano Letters*.

The key to perfect radiation endurance is perfect recovery of the damage created by energetic particles colliding with atoms in the material. The damage is mostly composed of atoms displaced from their original location in the crystal, becoming interstitial atoms and vacant sites. Since surfaces are perfect sinks for such defects, a porous material with a high surface-to-volume ratio has the potential to be extremely radiation tolerant, provided it is morphologically stable in a radiation environment.

continued on page 4

Nanoporous… In the paper, the researchers report on experiments and computer simulations on nanoscale gold foams that show the existence of a window in the parameter space where foams are radiation tolerant. The researchers analyzed these results in terms of a model for the irradiation response that quantitatively locates such a window, concluding that foams can be tailored to become radiation tolerant.

Their results represent a contribution to the exploration of the fundamental aspects of irradiation response at exceedingly small length scales. Further investigating the radiation behavior of nanofoams has therefore high payoff potential in the search for materials with radiation endurance.

The work is a result of modeling and simulations performed at the Universidad Nacional de Cuyo in Argentina, Louisiana State University, Virginia Polytechnic Institute and State University, and Lawrence Livermore National Laboratory. At Los Alamos, Alfredo Caro and Yongqiang Wang (MST-8), Amit Misra, Michael Nastasi, and Tom Picraux (all Center for Integrated Nanotechnologies, MPA-CINT) participated in the project.

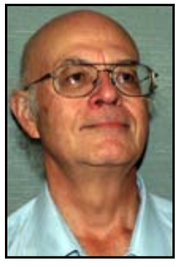
Work at Los Alamos was supported by the Center for Materials at Irradiation and Mechanical Extremes, a DOE Basic Energy Sciences Energy Frontier Research Center, and the Center for Intergrated Nanotechnologies, a DOE BES user facility. Jon Baldwin (MPA-CINT) assisted with sample synthesis.

Ongoing research is planned. The Laboratory Directed Research and Development program awarded funding to Caro and collaborators for the period 2012-2015 to explore the idea of nanoporous materials in depth.

Reference: "Are Nanoporous Materials Radiation Resistant?" *Nano Letters,* June 9, 2011.

Technical contact: Jose Alfredo Caro

Burgardt named 2011 American Welding Society Fellow



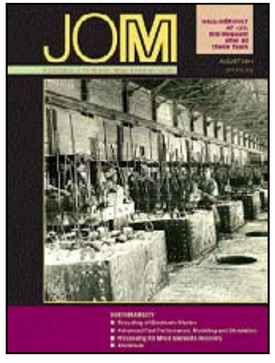
Paul Burgardt (Materials Technology: Metallurgy, MST-6) has been selected as a 2011 American Welding Society (AWS) Fellow. The AWS cited him "for sustained research and contributions in the area of welding physics, including surface tension driven fluid flow, arc spectroscopy and characterization of welding processes, including electron beam profiling and characterization. Further, for the promotion of the welding science and technology through his mentoring of students and through his lecture series on welding physics. Finally, for participation in welding related activities, such as the United States Department of Energy welding meetings and the AWS Professional Program."

Burgardt received a doctorate in solid state physics from Iowa State University, where he studied the magnetic and thermophysical properties of rare earth alloys. He joined the Laboratory in 1980 and is a member of the MST-6 welding and joining team.

The AWS was founded in 1919. It is a nonprofit organization with the goal of advancing the science, technology, and application of welding and related joining disciplines. The AWS established the honor of Fellow of the Society to recognize members for distinguished contributions to the field of welding science and technology and for promoting and sustaining the professional stature of the field. Election as a Fellow is based on the reputation and outstanding accomplishment of the individual. A maximum of 10 Fellows are selected each year. He will be recognized at the FABTECH International and AWS Welding Show in November in Chicago.

Technical contact: Paul Burgardt

MST-8 researchers contribute to *JOM* special issue



Chris Stanek and Carl Cady (both MST-8) contributed to a special issue of *JOM (Journal of Metals)* devoted to topics in sustainability. Stanek served as a guest editor for the featured topic Advanced Fuel Performance: Modeling and Simulation, and Cady served on the Nuclear Materials Committee.

As a guest editor, Stanek, along with Brian Worth (University of Tennessee, Knoxville) and Kurt Edsinger (Electric Power Research Institute, Palo Alto, Calif.), introduced articles highlighting work supported by the Department of Energy's Consortium for the Advanced Simulation of Light Water Reactors (CASL), a new Energy Innovation Hub. In a commentary article, "Perspective on Modeling Light Water Reactor Fuel Performance," the three guest

continued on page 5

JOM… editors also described the most common fuel failure mechanisms observed in pressurized water reactors.

As a technical committee member Cady was responsible for reviewing papers related to nuclear materials.

As part of CASL, Los Alamos provides technical leadership and expertise in the arena of materials science and development of advanced numerical models, or computer codes, that will aid in realistic simulations of reactor core and structural materials.

Other topics in the special issue covered recycling of electronic waste, processing for minor elements recovery, and aluminum. *JOM* is a technical journal published by The Minerals, Metals & Materials Society.

Reference: *JOM* **63**, 2011.

Technical contact: Chris Stanek

Celebrating service

Congratulations to the following MST employees celebrating service anniversaries this month:

Steven Valone, MST-8	30 years
Deniece Korzekwa, MST-16	25 years
Franz Freibert, MST-16	15 years
John Bernal, MST-6	5 years

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HeadsUP!

Seasonal flu vaccine available through local pharmacies

Present your LANS Blue Cross Blue Shield card

The 2011 seasonal flu vaccine is available now from area pharmacies, clinics, and personal medical providers. LANS employees can receive the seasonal vaccine from many local providers and pharmacies without a co-pay by presenting their Blue Cross Blue Shield of New Mexico health plan card. Employees should call ahead to check hours and availability. Occupational Medicine will not be providing the flu vaccine onsite except for those LANL workers who receive the flu vaccine as part of their medical surveillance program.

In addition, the seasonal flu vaccine will be available free of charge at many community health fairs between now and the end of October. A list of locations in New Mexico contracted by Blue Cross Blue Shield of New Mexico to provide the seasonal flu vaccine at no out-of-pocket charge to individuals covered by the BCBS health plan is at http://int.lanl.gov/news/newsbulletin/pdf/vaccine_network_list_092810.pdf. Employees are encouraged to call pharmacies first to find out what times the flu vaccine will be offered.

Tag your bags

Don't let your unattended belongings be mistaken for a suspicious package and "destroyed." Visit the Tag Your Bag Web page at int.lanl.gov/safety/emergency/emergency_management/tag_your_bag.shtml for more information on the importance of placing identification tags on bags and other personal carriers.

To report unattended and suspicious bags or packages, contact the Protective Force immediately at 7-4437.

Winter closure information

An all-employee memo about LANL's 2011 winter closure was issued by Associate Director for Business Services Mark Barth. Read the memo at int.lanl.gov/memos/2011/09/LANL-ALL2447.pdf for more information.